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(71) Applicant (for all designated States except US): **HOLGIA AKTIEBOLAG** [SE/SE]; Box 189, S-671 24 Arvika (SE).

(72) Inventors; and

(75) Inventors/Applicants (for US only): **LINDQVIST, Frank** [FI/DE]; Jargeuringen 30, D-68799 Reilingen (DE). **LINDQVIST, Henrik** [DE/SE]; Bergängsvägen 9, S-662 36 Åmål (SE).

(74) Agents: **HYNELL, Magnus et al.**; Hynell Patenttjänst AB, Patron Carls Väg 2, S-683 40 Hagfors/Uddeholm (SE).

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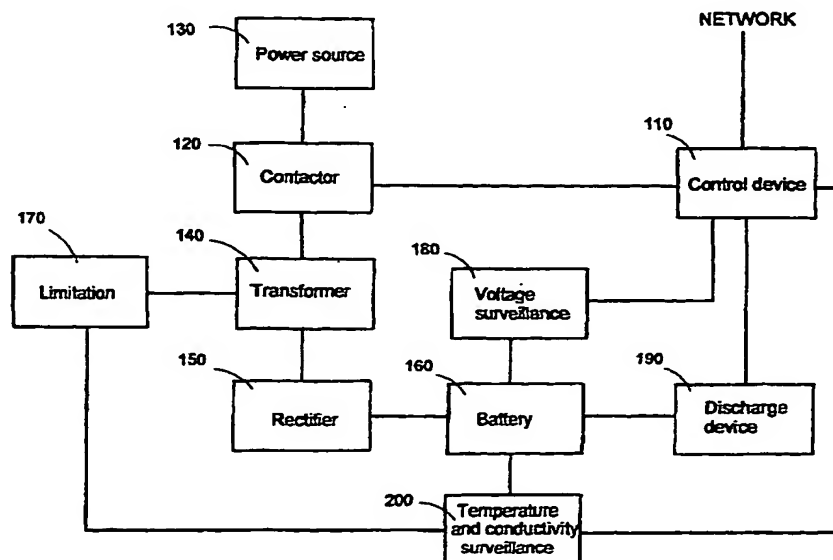
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(54) Title: METHOD AND DEVICE FOR BATTERIES



(57) Abstract: Method for treatment, in the form of regeneration, of accumulators having at least one cell, preferably lead batteries, in which a varying direct voltage from a charging unit is applied in intermittent current supply periods, which are interrupted by current free pauses, the direct voltage being sufficient to generate gas in the accumulator. During the treatment process, process data is registered, for at least one cell in the accumulator, which process data is used in order to control the treatment process.

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## METHOD AND DEVICE FOR BATTERIES

## TECHNICAL FIELD

5 The present invention relates to a method and device for treatment, in the form of re-generation, of accumulators having at least one cell, preferably lead batteries, in which a varying direct voltage from a charging unit, is applied in intermittent current supply periods which are interrupted by current free pauses, the direct voltage being sufficient to generate gas in the accumulator.

## 10 THE TECHNICAL STANDPOINT

In a charged lead accumulator, i.e. a lead battery, the active substance in the positive electrodes consists of lead superoxide,  $\text{PbO}_2$ , and of porous metallic lead in the negative electrodes. When the battery is discharged, these active substances are converted to lead sulphate,  $\text{PbSO}_4$ , sulphate ions being taken from the electrolyte, which is sulphuric acid.

15 In principle the process is the reversed at charging. Conventionally, when being re-charged by a continuous direct current, lead accumulators have, however, a limited ability of being recharged. The reason for this is not completely investigated, but it is supposed that influence is made by factors such as the products of discharge having a limited solubility in the electrolyte, it being considered that diffusion of the divalent lead

20 ions constitutes the limiting factor both at discharging and recharging. Furthermore, lead sulphate is a very poor conductor of electricity. All these circumstances often result in problems in connection with the charging of lead batteries, which i.a. risks being destroyed by inactive layers of lead sulphate which hinders the charging or decreases the capacity, and which eventually makes the battery useless. In addition, there are problems

25 in the form of different densities before and after the charging, which leads to the formation of sludge and to a decreased strength.

In WO 94/28610, there is presented a solution to the above problems in connection with the charging of accumulators, especially lead batteries. According to this document,

30 lead batteries may thus be charged by high current levels with a very good result and without a noticeable increase in temperature, when a direct voltage is being applied on the battery in intermittent current supply periods, interrupted by pauses in which no current is supplied, which periods are between about 0.5 seconds and about 10 seconds. The battery may be charged from a discharged state, in which case the current supply

35 intervals and the pause intervals are of approximately the same length, preferably between 0.5 and 1.5 seconds, one example presenting a current strength of 90 A being used, but it may also be maintenance charged by current supply periods of 0.5 seconds

at the most, the intervals there between being longer, e.g. 10 seconds or more, at lower current levels. The process is especially directed towards a fast process for charging.

One problem with the technique which is described in WO 94/28610 is that the method  
5 not is adapted to every single battery which is to be recharged. Neither is it possible to control the charging process, other than by setting base parameters for every charging that is done, in which setting there is made a choice as to whether the process is to constitute a charging of a discharged battery, or a maintenance charging of a non discharged battery. Neither is the method adjustable in consideration to experiences from  
10 chargings which have been previously performed, not is it directed upon regeneration.

In US 1,743,594 there is described another, older method of charging batteries in the shortest possible time, which accordingly does not aim at performing a regeneration of the battery. Thereby, the charging takes place by pulses of up to 100 A current strength  
15 during periods of 1.5-2 seconds, with pauses of the same length them between.

In US 3,963,976 there is described yet another method for charging batteries, which is not adapted to performing a regeneration of the same. The object of the method is to achieve a mixing through of the electrolyte by the circulation which takes place in connection with the formation of gas. In the document, it is stated that current strengths of  
20 up to 1500 A may be used, but at the same time it is warned that pulse periods of greater length may be harmful. It is in this connection stated that the pulse period may be 0.5-50 milliseconds, whereby the peak of the current strength only lasts about one millisecond. Furthermore, it is stated that the pulses should be generated at the same time as a constant charging takes place, it being recommended that the pulse treatment takes place at  
25 the end of the charging, i.e. when the battery is almost fully charged.

In WO 96/17426 there is described a system for charging of lead batteries, in which weak current pulses are used, mixed with extremely short current supply pulses, "current spikes", of relatively low current strengths. When the cell voltage reaches a level  
30 when generation of gas commences, the charging shifts to a constant voltage charging until the battery is fully charged. The controlling of the device makes use of a micro processor and is based upon measurements of the cell voltage and the internal resistance.

35 One problem which is not solved by any of the just mentioned methods is how to perform a regeneration of worn batteries in a way that can be optimised and controlled for

each given battery. Instead, the mentioned methods aims at achieving a fast and optimised charging or maintenance charging of more conventional type.

#### DESCRIPTION OF THE INVENTION

5 One object of the present invention is accordingly to offer a method for treatment, in the form of regeneration, of accumulators, the treatment process being controlled, in terms of current supply period, pauses and current strength, based on given input data. As input data, there is thereby used process data which are registered cell by cell during the treatment process, preferably at least the temperature and the conductivity of the electrolyte in the accumulator. Additional input data for the controlling of the treatment process are general data for the accumulator/battery, which general data are being fed in at the start of the treatment process. The controlling of the treatment process is preferably performed automatically, by hardware and software which is adapted for the process, preferably by use of a microcomputer or the like. For the controlling there may also be used process data from earlier treatment processes, such earlier process data constituting experience data which is used in order to optimise the treatment process taking place.

20 A basic object of the method and device according to the invention, is to achieve a regeneration of batteries which is non destructive to the battery. The treatment process should moreover be adaptable and controllable for every single battery.

Accordingly, there is according to the invention introduced a method for treatment of accumulators according to claim 1.

25 By the ability to absorb current/the conductivity being determined for at least one cell in the battery during the treatment process, the treatment process can be controlled by aid of a control unit, preferably e.g. a microcomputer, based on measured process data, preferably at least in the form of measured temperature and conductivity. The measuring of process data and the controlling based on these process data may be performed individually for all or essentially all cells in the accumulator. An alternative, preferred form of surveillance is to measure the total current which runs to the accumulator during the current supply period. This is done by surveillance of the mean value of temperature and conductivity, during a number of current supply periods, e.g. ten periods. When the mean value of the subsequent current supply periods remains in the main constant, e.g. within a limit of typically about 5%, for a longer period, e.g. about 1000 current supply

periods, this means that maximum/optimum regeneration is achieved with the parameters as set.

At the treatment process, a direct voltage is applied, usually a half-wave rectified alternating voltage from a common charging unit, in intermittent current supply periods, interrupted by current free pauses, which current supply periods have a duration of between 0.01 and 10 seconds, preferably between 0.01 and 0.4 seconds, and even more preferred between 0.1 and 0.5 seconds. Most preferred, a lowermost limit for the length of the current supply periods is 0.1 seconds, preferably 0.15 seconds, and an uppermost limit is 0.5 seconds, preferably 0.4 seconds and even more preferred 0.25 seconds. It has been shown in experimental tests that a very advantageous current supply period is 0.18 seconds. At the treatment, it is suitable to make the time periods for current supply and pause of unequal length, whereby the pauses are longer than the current supply periods, the pauses typically having a length of 1-20 seconds, preferably 1-10 seconds and even more preferred 1-5 seconds, typically about 3 seconds, it however being possible to vary them individually by controlling the process according to the present invention. The shortest pauses within the ranges are used in connection with the shortest current supply within the ranges, and vice versa. Thanks to the pauses being considerably longer than the current supply periods, there is also attained the advantage that the accumulator doesn't get too warm during the treatment. The current strength used in the current supply periods is 80-300 A or even more preferred up to 1000 A, at least in the case of so called traction batteries, the highest values being related to the accumulator being in a relatively good shape, and the lowest values to the same being in a bad shape. Most preferably, current strengths of at least 110 A, preferably at least 200 A and even more preferred at least 250 A, are used for these kind of traction batteries. For smaller batteries, e.g. batteries for passenger cars, there is on the contrary used lower current strengths, normally below 150 A, preferably below 110 A, but not lower than 80 A.

When the regeneration process according to the invention is commenced, the accumulator should not be entirely discharged but not fully charged either. Instead, it should suitably be partially charged, e.g. about half-way charged. Maintenance charging should be performed by constant, i.e. continuous charging.

At the treatment process according to the invention, contaminants in the form of sulphate crystals on the electrodes, which contaminants have been built up during discharge, are removed. By the very short current periods, of only some tenths of a second, with a high current, which are mixed with pauses of considerably greater length, there is

achieved an explode- or chock-like effect, whereby the crystals present in the battery acid are disintegrated, and pure lead is separated, which is returned to the electrodes (the lead plates) at the recharging of the battery. In order to achieve an optimum effect, each cell in the accumulator should reach a voltage of at least 2,5 V during the current supply periods, which is assured by the above mentioned current strengths and pulse times. Thereby, the energy supply during the current supply periods is higher than for the known methods, the object of which is only charging and not regeneration, but seen as a total, the energy supply is relatively low, thanks to the relatively long pauses. As a total, pulsing at 300 A e.g., corresponds to a charging current of about 20 A.

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According to the invention, the treatment process is performed as a regeneration process, whereby a certain, but normally not complete, charging of the accumulator takes place at the same time as the regeneration, as a side effect of the treatment. After the regeneration, there is suitably performed a discharge of the accumulator, followed by a charging. This charging too may be performed by aid of a method which corresponds to the method according to the invention, the process however being controlled in a way which is optimal for the charging. It is however preferred that the charging takes place with a constant, i.e. continuous, current supply after the regeneration. According to an especially preferred embodiment, the treatment process is performed in a number of cycles, preferably 5-30, and even more preferred 5-20 cycles for traction batteries. In this case, each cycle consists of a regeneration part, typically having current supply periods of about 0.18 seconds, and pauses of about 3 seconds, and a charging part with standard charging, i.e. with continuous current supply of typically 2,34 V. Thereby, each regeneration part lasts for 2-8 hours, preferably 2-6 hours and most preferred about 6 hours, the constant charging parts lasting for 0.5-2 hours, preferably about 1 hour. Without binding the invention to a certain theory, it is thereby considered that the constant charging acts in the form of a formatting of the electrode surfaces, in a way that corresponds to what takes place at the charging of an entirely new battery. Hereby, a maximum surface with an amorphous structure is achieved on the electrodes. It is realised that the treatment process for the regeneration is relatively long, and it is moreover not an object per se that the process should be shortened in relation to known processes for the charging of batteries. Typically, the treatment time according to the invention is at least 12 hours long, preferably at least 24 hours long, even more preferred 48 hours long and up to several days long. As an alternative, regeneration and charging may be performed at the same time by the method according to the invention, during total treatment times of the same length.

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According to one aspect of the invention, process data is registered continuously during the entire or essentially the entire treatment process, the controlling of the treatment process too being performed continuously. Preferably, the pulse length/current supply periods, the pauses and optionally the current strength are arranged to be adjusted/controlled dynamically during the course of the treatment process. A control unit is used at the dynamic adjusting/controlling, preferably a micro-controller, which makes use of a table of experience values, which is stored in its memory, in order to adapt current supply and pause lengths in the regeneration part of the treatment process. The maximum amplitude of the current supply periods may also be limited, with consideration to general data for the accumulator. Thereby, the amplitude should not exceed the maximum allowed charging current for the accumulator. The controlling takes place entirely by aid of the micro-controller, which controls e.g. a triac etc., partially via a D/A-converter.

According to another aspect of the invention, the registering of process data takes place during a predetermined time period of the entire treatment time, preferably during start-up of the treatment. During the start-up of the treatment, there is also an opportunity to detect cells in the accumulator which are damaged, which damaged cells behave in a non normal way, e.g. by exhibiting very high voltages at the treatment.

According to yet another aspect of the invention, process data, at least in the form of temperature and conductivity, is registered by sensors adapted therefore. This may be performed by the accumulator being opened, so that the sensor may be introduced down into the electrolyte in each cell where process data is to be registered. As an alternative, the measuring/registering may take place from the outside, by external registering of temperature and conductivity, e.g. by inductive measuring. The cells of the accumulator may thereby be provided with stationary sensors, which inductively communicates through the battery housing by e.g. RFID technique.

The temperature sensors may be standard analogous temperature transmitters which are, e.g., connected to PT100 input in the electronics. Of course, digital transmitters are conceivable too. The measurement of conductivity preferably takes place by two electrodes, preferably of platinum, and therefore adapted electronics which measures the conductivity of the electrolyte during the pauses in the treatment process. Other sensors, adapted to the purpose, may be used too.

According to yet another aspect of the invention, the general data for the battery, which are used as input data for controlling of the treatment process, are constituted by any,

some or all input data in the group consisting of name of the customer, date, battery manufacturer, type number for the battery, type values for the battery, year of manufacture, time of the first operational use of the battery, time between each previously performed treatment, type of vehicle in which the battery is used and data registered in previous treatments, e.g. cell voltage and electrolyte density. These general data, or at least a main part of them, may be stored in a data storing unit attached to the battery, e.g. a chips, a bar code, or in a data bank in the device for the treatment, or similar.

According to yet another aspect of the invention, the treatment of a certain battery is performed when the conductivity which is determined at a certain cell voltage for this specific battery has reached a predetermined critical value.

According to another aspect of the invention, several devices for treatment of accumulators may share the same old process data from previous treatment sessions, by being connected to each other in a network. Hereby, a single server, in the network, may contain a database which is common for the devices, having experience values from previous treatment processes. Thus, there may be used experiences/process data from previous treatments of batteries of the same or similar type in other treatment devices which also are connected to the network, for controlling the treatment of a certain battery in a first treatment device, which is connected to the network. The control units of the batteries may be connected to the network by GSM and/or local radio/telemetric communication systems, such as dect, blue tooth etc., or corresponding systems. By the network and the common server, it is also possible to remotely survey the devices and to upgrade the software of their control units.

Since every accumulator behaves individually, which strongly depends on its history, i.e. the treatment and environmental influence which it has been exposed to, the optimal treatment method for different accumulators varies. By putting together a database, according to the above, which contains essential parameters for each treated accumulator, before, during and after previously performed regenerations in combination with the type of the accumulator, there may be put together an algorithm (e.g. in the form of an equation or matrix), in order to achieve the best possible treatment process for each new treatment of an accumulator. From a commercial point of view, it may thereby be of extra importance to be able to predict the expected treatment time. Such a database may be built by combining the data which has been collected from the greatest possible number of regenerating machines. This may be done by these data being manually combined and distributed, which however is practically difficult why the best solution is to

connect the machines in a network, permanently or temporarily. Thereby, there may be used a classic Server-Client network (LAN), or the Internet, in order to in a simple way achieve a global network.

5 DESCRIPTION OF THE FIGURE

In the following, a device according to the invention, for the performance of the method according to the invention, will be described, while referring to Fig. 1, which is a block diagram.

- 10 The auto monitor control is achieved by a control unit 110, for example a suitably programmed microprocessor and its surrounding circuits, which controls a switch means, such as a contactor 120. This is breaking and closing a feed path for electrical energy, which is supplied by a voltage source 130, e.g. the common electricity supply network. The voltage is transformed into a desired value by means of a transformer 140, where  
15 after it is supplied to a rectifier 150. Thereafter, the rectified voltage is supplied to the battery 160, as a treatment voltage.

- A limitation circuit 170 acts as an auto monitor control of current and temperature. If the feed current or the battery temperature, which are surveyed by the temperature and  
20 conductivity surveillance 200, becomes too high, the rectifier 150, and thereby the feed to the battery 160, is deactivated.

- The control unit 110 controls the contactor 120 based on registered process data, which process data are registered by means of the temperature and conductivity surveillance  
25 200 and a voltage surveillance circuit 180. The control unit 110 also makes use of general data for the specific battery, for the control, as well as older process data and general data, which are available to the control unit via a network connection. Moreover, the control unit 110 controls a discharge circuit 190, by which the battery can be discharged at a predetermined current.

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The invention is not limited by the above described embodiments, but may be varied within the scope of the claims. The device and method according to the invention is e.g. also suitable for other types of accumulators than lead batteries, e.g. nickel-cadmium and nickel-iron accumulators.

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## CLAIMS

1. Method for treatment, in the form of regeneration, of accumulators having at least one cell, preferably lead batteries, in which a varying direct voltage from a charging unit is applied in intermittent current supply periods, which are interrupted by current free pauses, the direct voltage being sufficient to generate gas in the accumulator, characterised in that process data, for at least one cell in the accumulator, is registered during the treatment process, which process data is used in order to control the treatment process.
2. Method according to claim 1, characterised in that a conductivity in an electrolyte in the cell, and/or a temperature in the electrolyte in the cell constitutes said process data.
3. Method according to claim 1 or 2, characterised in that sensors for said process data are introduced down into the electrolyte in each cell where process data is to be registered.
4. Method according to any of the preceding claims, characterised in that what is controlled during the treatment process is a length of said current supply periods, which may be between 0.01 and 10 seconds, preferably at least 0.1 seconds, even more preferred at least 0.15 seconds and 0.5 seconds at the most, preferably 0.4 seconds at the most and even more preferred 0.25 seconds at the most, a length of said pauses, which may be between 1-20 seconds, preferably 1-10 seconds and even more preferred 1-5 seconds, typically about 3 seconds, the current supply periods preferably being considerably shorter than the pauses.
5. Method according to any of the preceding claims, characterised in that a current is applied during the current supply periods, which current is strong enough in order for each cell in the accumulator to reach a voltage of at least 2.5 V during the current supply periods.
6. Method according to any of the preceding claims, characterised in that a current level during said current supply periods amounts to between 80 and 1000 A, preferably at least 110 A, preferably at least 200 A and even more preferred at least 250 A, but 1000 A at the most.

7. Method according to any of claims 1-5, characterised in that a current level during said current supply periods is between 80 and 1000 A, preferably 150 A at the most and even more preferred 110 A at the most.
- 5 8. Method according to any of the preceding claims, characterised in that the treatment process is performed in a number of cycles, preferably 5-30 and even more preferred 5-20 cycles, each cycle consisting of a regeneration part of 2-8 hours, preferably 2-6 hours and most preferred about 6 hours, and a charge part, preferably using standard charging, i.e. using a continuous current supply, during 0.5-2 ours, preferably about 1 hour.
- 10 9. Method according to any of the preceding claims, characterised in that said registering of process data and said controlling, is continuously performed during the entire or essentially the entire treatment process.
- 15 10. Method according to any of claims 1-8, characterised in that said registering of process data is performed during a predetermined time period of the entire treatment period, preferably during start up of the treatment.
- 20 11. Method according to any of the preceding claims, characterised in that said registering of process data and controlling based on this process data, is individually performed for all or essentially all cells in the accumulator.
- 25 12. Method according to any of the preceding claims, characterised in that the total current running to the accumulator during the current supply periods is registered, preferably by surveying of a mean value for said process data for a small number of current supply periods, optimal control, and thereby optimal treatment, thereafter being ensured when the mean value of the succeeding current supply periods, during a longer period, remains in the main constant.
- 30 13. Method according to any of the preceding claims, characterised in that general data, for each individual accumulator, is used for the controlling of the treatment process, which general data preferably is chosen from the group consisting of name of the customer, date, accumulator manufacturer, type number for the accumulator, type values for the accumulator, year of manufacture, time of the first operational use of the accumulator, time between previously performed treatments, type of device in which the accumulator is used, and which
- 35

general data preferably is registered automatically at start up of the treatment process.

- 5 14. Method according to claim 13, c h a r a c t e r i s e d i n that older general data and process data too, for other accumulators and/or for previous treatments of the specific accumulator, are used for the controlling of the treatment process.
- 10 15. Method according to claim 14, c h a r a c t e r i s e d i n that access to said older general data and older process data is ensured by connection to a network having a common database for these data for different devices for the treatment of accumulators.
- 15 16. Method according to claim 15, c h a r a c t e r i s e d i n that said network also is arranged to be used for the surveillance of the treatment process and/or for the upgrading of software for the treatment process.
- 20 17. Device for treatment, in the form of regeneration, of accumulators having at least one cell, preferably lead batteries, which device comprises a transformer having a primary coil adapted to be connected to the electricity supply network, a secondary coil, a rectifier connected to the secondary coil, a positive and a negative cable clip, adapted to be connected to an accumulator which is to be treated, and an automatic actuator connected to the primary coil for intermittent connecting and disconnecting of the electricity supply network with short current supply periods interrupted by current free pauses, c h a r a c t e r i s e d i n
- 25 means for registering/measuring of process data, at least in one cell of the accumulator, and means for controlling the treatment process based on this process data.
- 30 18. Device according to claim 17, c h a r a c t e r i s e d i n that sensors for registering/measuring a conductivity in an electrolyte in the cell, constitutes said means for registering/measuring process data, and/or sensors for registering/measuring a temperature in the electrolyte in the cell, said registering/measuring preferably being arranged to be performed by opening of the accumulator and applying said sensors.
- 35 19. Device according to any of claims 17-18, c h a r a c t e r i s e d i n that said means for registering/measuring process data are arranged to individually regis-

ter/measure process data in all or essentially all cells of the accumulator, the treatment process preferably being arranged to be individually controlled in these cells, based on the process data for each cell.

- 5 20. Device according to any of claims 17-19, characterised in that said means for controlling the treatment process comprises a control unit, preferably a microcomputer, and means for dynamically, during the treatment process, altering the length of said current supply periods to between 0.01 and 10 seconds, preferably at least 0.1 seconds, even more preferred at least 0.15 seconds and 0.5  
10 seconds at the most, preferably 0.4 seconds at the most and even more preferred 0.25 seconds at the most, a length of said pauses, which may be between 1-20 seconds, preferably 1-10 seconds and even more preferred 1-5 seconds, typically about 3 seconds, the current supply periods preferably being considerably shorter than the pauses, and optionally, the current level used.
- 15 21. Device according to any of claims 17-20, characterised in that the device is arranged to yield a current during said current supply periods, which current is strong enough in order for each cell in the accumulator to be brought to reach a voltage of at least 2.5 V during the current supply periods.
- 20 22. Device according to any of claims 17-21, characterised in that the device is arranged to yield a current level during said current supply periods, which current level may amount to between 80 and 1000 A, preferably at least 110 A, preferably at least 200 A and even more preferred at least 250 A, but 1000 A at  
25 the most.
23. Device according to any of claims 17-21, characterised in that the device is arranged to yield a current level during said current supply periods, which current level may amount to between 80 and 1000 A, preferably 150 A at the  
30 most and even more preferred 110 A at the most.
24. Device according to any of claims 17-23, characterised in means for the, preferably automatic, registering/feeding in of general data, for each individual accumulator, which general data preferably is chosen from the group consisting of name of the customer, date, accumulator manufacturer, type number  
35 for the accumulator, type values for the accumulator, year of manufacture, time of the first operational use of the accumulator, time between previously per-

formed treatments, type of device in which the accumulator is used.

5 25. Device according to claim 24, c h a r a c t e r i s e d i n that said device comprises means for connecting it to a database, preferably via a network, for use of older general data and process data for previous treatment processes, for other accumulators and/or for previous treatments of the specific accumulator, in the controlling of the treatment process.

10 26. Device according to claim 25, c h a r a c t e r i s e d i n that said network also is arranged to be used for the surveillance of the treatment process and/or for the upgrading of software for the treatment process.

**AMENDED CLAIMS**

[received by the International Bureau on 10 November 2000 (10.11.00);  
original claims 1-26 amended (5 pages)]

1. Method for treatment of accumulators having at least one cell, preferably lead batteries, in which a varying direct current from a charging unit is applied in intermittent current supply periods, which are interrupted by current free pauses, the direct current being sufficient to generate gas in the accumulator, characterised in that said treatment constitutes a regeneration process, wherein said current supply periods have a length of between 0.01 and 0.5 seconds, a current level during said current supply periods amounting to between 80 and 1000 A, said pauses have a length of 1-20 seconds, and wherein process data, for at least one cell in the accumulator, is registered during the treatment process, which process data is used in order to control the treatment process.
2. Method according to claim 1, characterised in that a conductivity in an electrolyte in the cell, and/or a temperature in the electrolyte in the cell constitutes said process data.
3. Method according to claim 1 or 2, characterised in that sensors for said process data are introduced down into the electrolyte in each cell where process data is to be registered.
4. Method according to any of the preceding claims, characterised in that what is controlled during the treatment process is a length of said current supply periods, which may be between 0.01 and 0.5 seconds, preferably at least 0.1 seconds, even more preferred at least 0.15 seconds and 0.4 seconds at the most, preferably 0.25 seconds at the most, a length of said pauses, which may be between 1-20 seconds, preferably 1-10 seconds and even more preferred 1-5 seconds, typically about 3 seconds, the current supply periods preferably being considerably shorter than the pauses.
5. Method according to any of the preceding claims, characterised in that a current is applied during the current supply periods, which current is strong enough in order for each cell in the accumulator to reach a voltage of at least 2.5 V during the current supply periods.
6. Method according to any of the preceding claims, characterised in that said current level during said current supply periods amounts to at least 110 A,

preferably at least 200 A and even more preferred at least 250 A, but 1000 A at the most.

- 5           7. Method according to any of claims 1-5, characterised in that a current level during said current supply periods is 150 A at the most, preferably 110 A at the most.
- 10           8. Method according to any of the preceding claims, characterised in that the treatment process is performed in a number of cycles, preferably 5-30 and even more preferred 5-20 cycles, each cycle consisting of a regeneration part of 2-8 hours, preferably 2-6 hours and most preferred about 6 hours, and a charge part, preferably using standard charging, i.e. using a continuous current supply, during 0.5-2 hours, preferably about 1 hour.
- 15           9. Method according to any of the preceding claims, characterised in that said registering of process data and said controlling, is continuously performed during the entire or essentially the entire treatment process.
- 20           10. Method according to any of claims 1-8, characterised in that said registering of process data is performed during a predetermined time period of the entire treatment period, preferably during start up of the treatment.
- 25           11. Method according to any of the preceding claims, characterised in that said registering of process data and controlling based on this process data, is individually performed for all or essentially all cells in the accumulator.
- 30           12. Method according to any of the preceding claims, characterised in that the total current running to the accumulator during the current supply periods is registered, preferably by surveying of a mean value for said process data for a small number of current supply periods, optimal control, and thereby optimal treatment, thereafter being ensured when the mean value of the succeeding current supply periods, remains in the main constant.
- 35           13. Method according to any of the preceding claims, characterised in that general data, for each individual accumulator, is used for the controlling of the treatment process, which general data preferably is chosen from the group consisting of name of the customer, date, accumulator manufacturer, type number

for the accumulator, type values for the accumulator, year of manufacture, time of the first operational use of the accumulator, time between previously performed treatments, type of device in which the accumulator is used, and which general data preferably is registered automatically at start up of the treatment process.

14. Method according to claim 13, characterised in that older general data and process data too, for other accumulators and/or for previous treatments of the specific accumulator, are used for the controlling of the treatment process.

15. Method according to claim 14, characterised in that access to said older general data and older process data is ensured by connection to a network having a common database for these data for different devices for the treatment of accumulators.

16. Method according to claim 15, characterised in that said network also is arranged to be used for the surveillance of the treatment process and/or for the upgrading of software for the treatment process.

17. Device for treatment of accumulators having at least one cell, preferably lead batteries, which device comprises a transformer having a primary coil adapted to be connected to the electricity supply network, a secondary coil, a rectifier connected to the secondary coil, a positive and a negative cable clip, adapted to be connected to an accumulator which is to be treated, and an automatic actuator connected to the primary coil for intermittent connecting and disconnecting of the electricity supply network with short current supply periods interrupted by current free pauses, characterised in that said device constitutes a device for a regeneration process, the device being arranged to conduct said current supply periods with a length of between 0.01 and 0.5 seconds, a current level during said current supply periods being arranged to amount to between 80 and 1000 A, and to conduct said pauses with a length of 1-20 seconds, and in that the device also comprises means for registering/measuring of process data, at least in one cell of the accumulator, and means for controlling the treatment process based on this process data.

18. Device according to claim 17, characterised in that sensors for registering/measuring a conductivity in an electrolyte in the cell, constitutes said means

for registering/measuring process data, and/or sensors for registering/measuring a temperature in the electrolyte in the cell, said registering/measuring preferably being arranged to be performed by opening of the accumulator and applying said sensors.

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19. Device according to any of claims 17-18, characterised in that said means for registering/measuring process data are arranged to individually register/measure process data in all or essentially all cells of the accumulator, the treatment process preferably being arranged to be individually controlled in these cells, based on the process data for each cell.

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20. Device according to any of claims 17-19, characterised in that said means for controlling the treatment process comprises a control unit, preferably a microcomputer, and means for dynamically, during the treatment process, altering the length of said current supply periods to between 0.01 and 0.5 seconds, preferably at least 0.1 seconds, even more preferred at least 0.15 seconds and 0.4 seconds at the most, preferably 0.25 seconds at the most, a length of said pauses, which may be between 1-20 seconds, preferably 1-10 seconds and even more preferred 1-5 seconds, typically about 3 seconds, the current supply periods preferably being considerably shorter than the pauses, and optionally, the current level used.

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21. Device according to any of claims 17-20, characterised in that the device is arranged to yield a current during said current supply periods, which current is strong enough in order for each cell in the accumulator to be brought to reach a voltage of at least 2.5 V during the current supply periods.

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22. Device according to any of claims 17-21, characterised in that the current level during said current supply periods is at least 110 A, preferably at least 200 A and even more preferred at least 250 A, but 1000 A at the most.

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23. Device according to any of claims 17-21, characterised in that the current level during said current supply periods is 150 A at the most, preferably 110 A at the most.

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24. Device according to any of claims 17-23, characterised in means for the, preferably automatic, registering/feeding in of general data, for each indi-

vidual accumulator, which general data preferably is chosen from the group consisting of name of the customer, date, accumulator manufacturer, type number for the accumulator, type values for the accumulator, year of manufacture, time of the first operational use of the accumulator, time between previously performed treatments, type of device in which the accumulator is used.

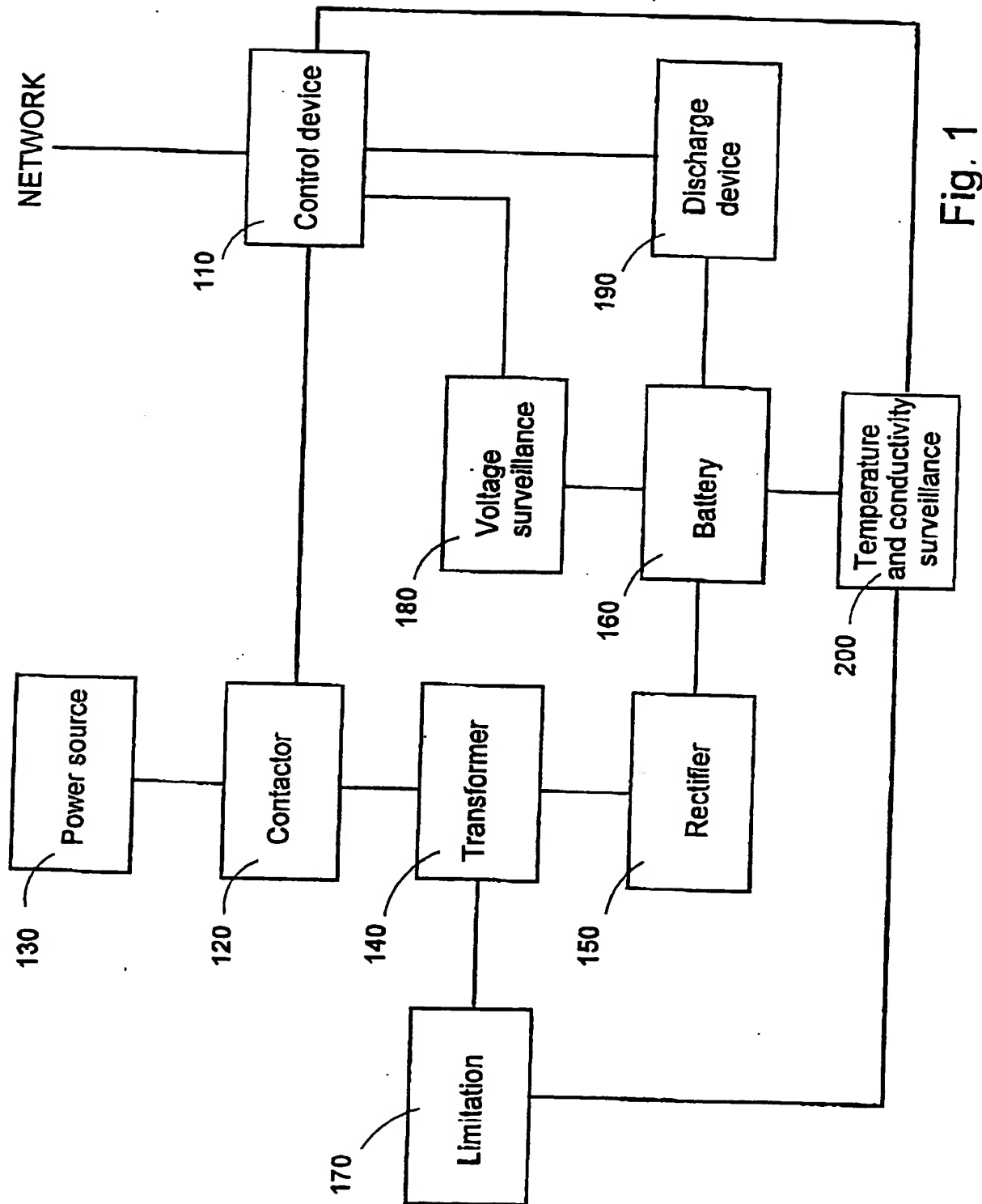
5

25. Device according to claim 24, characterised in that said device comprises means for connecting it to a database, preferably via a network, for use of older general data and process data for previous treatment processes, for other accumulators and/or for previous treatments of the specific accumulator, in the controlling of the treatment process.

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26. Device according to claim 25, characterised in that said network also is arranged to be used for the surveillance of the treatment process and/or for the upgrading of software for the treatment process.

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## INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE 00/01049

## A. CLASSIFICATION OF SUBJECT MATTER

IPC7: H02J 7/00, H01M 10/44

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: H02J, H01M

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 9428610 A1 (BERNT WIHK), 8 December 1994 (08.12.94), page 2, line 26 - line 34; page 4, line 33 - page 5, line 12	1,17
Y	--	2,3,18
X	WO 9617426 A1 (MANITOBA, LTD), 6 June 1996 (06.06.96), page 13, line 26 - page 14, line 2; page 16, line 3 - line 5	1,2,17
Y	--	3
Y	US 4650729 A (MASASHI NAKAMURA ET AL), 17 March 1987 (17.03.87), column 2, line 45 - line 47, figure 2	2,3,18
	--	

☒ Further documents are listed in the continuation of Box C.☒ See patent family annex.

- \* Special categories of cited documents:
  - "A" document defining the general state of the art which is not considered to be of particular relevance
  - "E" earlier document but published on or after the international filing date
  - "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
  - "O" document referring to an oral disclosure, use, exhibition or other means
  - "P" document published prior to the international filing date but later than the priority date claimed
  - "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
  - "X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
  - "Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
  - "&" document member of the same patent family

Date of the actual completion of the international search

25 October 2000

Date of mailing of the international search report

06 - 11 - 2000

Name and mailing address of the ISA/  
 Swedish Patent Office  
 Box 5055, S-102 42 STOCKHOLM  
 Facsimile No. +46 8 666 02 86

Authorized officer

Birgit Politt/MN  
 Telephone No. +46 8 782 25 00

# INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE 00/01049

## C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 0293664 A2 (POWER-TECH SYSTEMS CORPORATION), 17 May 1988 (17.05.88), column 5, line 21 - line 37, figure 2, abstract  --	1,17
A	DE 19629569 A1 (BAE BERLINER BATTERIEFABRIK GMBH), 22 January 1998 (22.01.98), column 2, line 50 - line 52, abstract  -- -----	3

# INTERNATIONAL SEARCH REPORT

International application No.  
**PCT/SE00/01049**

## Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:  
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☐ Claims Nos.:  
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
3. ☐ Claims Nos.:  
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).:

## Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

**See next page**

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.: **1, 2, 3, 17, 18**

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest.  
☐ No protest accompanied the payment of additional search fees.

# INTERNATIONAL SEARCH REPORT

International application No.  
PCT/SE00/01049

The international application is considered not to comply with the requirements of unity of invention. A posteriori, the invention defines 9 independent inventions:

1. Claims 1-3, 17-18 directed to a method and a device for reconditioning batteries with technical feature regarding process data.
2. Claims 4 and 20 directed to a method and a device with technical feature regarding controlling the length of current periods
3. Claims 5-7 and 21-23 directed to a method and a device with technical feature regarding current intensity
4. Claim 8 directed to a method with technical feature regarding treatment cycles
5. Claim 9 -10 directed to a method with additional features regarding registration of process data
6. Claims 11 and 19 directed to a method and device with technical feature regarding individual control of process data in every battery cell
7. Claim 12 directed to a method with additional features regarding registration of current
8. Claims 13-15 and 24-25 directed to a method and a device with technical features regarding general battery data
9. Claims 16 and 26 directed to a method and a device with technical features regarding a network

The invention described in claim 1 and 17 lacks inventive step due to what is known from the following documents:

From WO9428610 is known a pulse treatment method and a device for lead batteries. A conventional charging unit supplies intermittent current periods, which are interrupted by periods in which no current is supplied (see column 2 line 26-32). The treatment is suited for reconditioning of batteries that have lost their efficiency due to sulfation. The battery is charged until the acid content of the "best" cells reaches a normal value (see column 4 line 33 - column 5 line 12). This document represents the most relevant technique known in the art. A person skilled in the art learns from WO9617426 that monitoring process data could control charging and reconditioning process of batteries. These process data are processed to select the charging current and spike current applied to the battery. (see abstract; page 13 line 26-column 14 line 2; page 9 line 13-19, page 16 line 3-5)

.../...

INTERNATIONAL SEARCH REPORT

International application No.  
PCT/SE00/01049

Accordingly it is closely allied for a person skilled in the art to come to the invention as it is described in claims 1 and 17.

The features that group 1 and the other groups have in common - the registration and use of process data to control reconditioning of batteries - lack inventive step due to what is known from the cited documents. Consequently, the common feature is not a special technical feature within the meaning of PCT Rule 13.2, second sentence, since it makes no contribution over prior art.

Since no other common feature exists which can be considered as a special technical feature within the meaning of PCT Rule 13.2, second sentence, no technical relationship within the meaning of PCT Rule 13 can be determined between the different inventions.

Consequently, it appears, a posteriori, that claims of group 1-9 do not satisfy the requirements of unity of invention.

**INTERNATIONAL SEARCH REPORT**  
Information on patent family members

03/10/00

International application No.  
PCT/SE 00/01049

Patent document cited in search report			Publication date	Patent family member(s)		Publication date
WO	9428610	A1	08/12/94	AT	171822 T	15/10/98
				AU	686633 B	12/02/98
				AU	6902094 A	20/12/94
				CA	2163672 A	08/12/94
				CZ	9503003 A	14/02/96
				DE	69413687 D,T	29/04/99
				EP	0704113 A,B	03/04/96
				ES	2124891 T	16/02/99
				FI	955623 A	24/11/95
				HU	75414 A	28/05/97
				HU	9503293 D	00/00/00
				JP	9504678 T	06/05/97
				NO	954693 A	20/11/95
				NZ	266912 A	24/04/97
				PL	311692 A	04/03/96
				SE	510437 C	25/05/99
				SE	9301756 A	25/11/94
				SK	142895 A	03/07/96
				US	5701069 A	23/12/97
WO	9617426	A1	06/06/96	AU	698284 B	29/10/98
				AU	3920695 A	19/06/96
				CA	2206431 A	06/06/96
				EP	0795223 A	17/09/97
				FI	972283 A	25/07/97
				JP	10509838 T	22/09/98
				NO	972421 A	30/07/97
				US	5648714 A	15/07/97
US	4650729	A	17/03/87	DE	3528673 A,C	13/02/86
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EP	0293664	A2	17/05/88	AU	596341 B	26/04/90
				AU	1690188 A	01/12/88
				BR	8802655 A	27/12/88
				JP	63305721 A	13/12/88
				US	4843299 A	27/06/89
				US	5049804 A	17/09/91
DE	19629569	A1	22/01/98	NONE		

## PCT REQUEST

P1446-100A

Original (for SUBMISSION) - printed on 23.05.2000 11:48:53 AM

0	For receiving Office use only	
0-1	International Application No.	<b>PCT/ SE 00 / 0 1 0 4 9</b>
0-2	International Filing Date	<b>2 4 -05- 2000</b>
0-3	Name of receiving Office and "PCT International Application"	<b>The Swedish Patent Office PCT International Application</b>
0-4	Form - PCT/RO/101 PCT Request Prepared using	<b>PCT-EASY Version 2.90 (updated 10.05.2000)</b>
0-5	Petition The undersigned requests that the present international application be processed according to the Patent Cooperation Treaty	
0-6	Receiving Office (specified by the applicant)	<b>Swedish Patent Office (RO/SE)</b>
0-7	Applicant's or agent's file reference	<b>P1446-100A</b>
I	Title of invention	<b>METHOD AND DEVICE FOR BATTERIES</b>
II	Applicant	
II-1	This person is:	<b>applicant only</b>
II-2	Applicant for	<b>all designated States except US</b>
II-4	Name	<b>HOLGIA AKTIEBOLAG</b>
II-5	Address:	<b>Box 189 S-671 24 ARVIKA Sweden</b>
II-6	State of nationality	<b>SE</b>
II-7	State of residence	<b>SE</b>
III-1	Applicant and/or inventor	
III-1-1	This person is:	<b>applicant and inventor</b>
III-1-2	Applicant for	<b>US only</b>
III-1-4	Name (LAST, First)	<b>LINDQVIST, Frank</b>
III-1-5	Address:	<b>Jargeuringen 30 D-68799 REILINGEN Germany</b>
III-1-6	State of nationality	<b>FI</b>
III-1-7	State of residence	<b>DE</b>

PCT REQUEST

P1446-100A

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III-2	<b>Applicant and/or inventor</b>	
III-2-1	This person is:	applicant and inventor
III-2-2	Applicant for	US only
III-2-4	Name (LAST, First)	LINDQVIST, Henrik
III-2-5	Address:	Bergängsvägen 9 S-662 36 ÅMÅL Sweden
III-2-6	State of nationality	DE
III-2-7	State of residence	SE
IV-1	<b>Agent or common representative; or address for correspondence</b> The person identified below is hereby/has been appointed to act on behalf of the applicant(s) before the competent International Authorities as:	agent
IV-1-1	Name (LAST, First)	HYNELL, Magnus
IV-1-2	Address:	Hynell Patenttjänst AB Patron Carls väg 2 S-683 40 HAGFORS/UDDEHOLM Sweden
IV-1-3	Telephone No.	+46 563 23520
IV-1-4	Facsimile No.	+46 563 23696
IV-1-5	e-mail	headoffice@hynell.se
IV-2	<b>Additional agent(s)</b>	additional agent(s) with same address as first named agent
IV-2-1	Name(s)	KYLIN, Peter; BJÖRKMAN, Annika; LUNDAHL, Kjell; WASSÉN, Helena
V	<b>Designation of States</b>	
V-1	Regional Patent (other kinds of protection or treatment, if any, are specified between parentheses after the designation(s) concerned)	AP: GH GM KE LS MW MZ SD SL SZ TZ UG ZW and any other State which is a Contracting State of the Harare Protocol and of the PCT EA: AM AZ BY KG KZ MD RU TJ TM and any other State which is a Contracting State of the Eurasian Patent Convention and of the PCT EP: AT BE CH&LI CY DE DK ES FI FR GB GR IE IT LU MC NL PT SE and any other State which is a Contracting State of the European Patent Convention and of the PCT OA: BF BJ CF CG CI CM GA GN GW ML MR NE SN TD TG and any other State which is a member State of OAPI and a Contracting State of the PCT

## PCT REQUEST

P1446-100A

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V-2	National Patent (other kinds of protection or treatment, if any, are specified between parentheses after the designation(s) concerned)	AE AG AL AM AT (patent and utility model) AU AZ BA BB BG BR BY CA CH&LI CN CR CU CZ (patent and utility model) DE (patent and utility model) DK (patent and utility model) DM DZ EE (patent and utility model) ES FI (patent and utility model) GB GD GE GH GM HR HU ID IL IN IS JP KE KG KP KR (patent and utility model) KZ LC LK LR LS LT LU LV MA MD MG MK MN MW MX MZ NO NZ PL PT RO RU SD SE SG SI SK (patent and utility model) SL TJ TM TR TT TZ UA UG US UZ VN YU ZA ZW
V-5	Precautionary Designation Statement In addition to the designations made under items V-1, V-2 and V-3, the applicant also makes under Rule 4.9(b) all designations which would be permitted under the PCT except any designation(s) of the State(s) indicated under item V-6 below. The applicant declares that those additional designations are subject to confirmation and that any designation which is not confirmed before the expiration of 15 months from the priority date is to be regarded as withdrawn by the applicant at the expiration of that time limit.	
V-6	Exclusion(s) from precautionary designations	NONE
VI-1	Priority claim of earlier national application	
VI-1-1	Filing date	15 June 1999 (15.06.1999)
VI-1-2	Number	9902286-5
VI-1-3	Country	SE
VI-2	Priority document request The receiving Office is requested to prepare and transmit to the International Bureau a certified copy of the earlier application(s) identified above as item(s):	VI-1
VII-1	International Searching Authority Chosen	Swedish Patent Office (ISA/SE)
VII-2	Request to use results of earlier search; reference to that search	
VII-2-1	Date	15 June 1999 (15.06.1999)
VII-2-2	Number	9902286-5
VII-2-3	Country (or regional Office)	SE


24 -05- 2000

4/4

## PCT REQUEST

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<b>VIII</b>	<b>Check list</b>	<b>number of sheets</b>	<b>electronic file(s) attached</b>
VIII-1	Request	4 ✓	-
VIII-2	Description	8 ✓	-
VIII-3	Claims	5 ✓	-
VIII-4	Abstract	1 ✓	p1446apct.txt
VIII-5	Drawings	1 ✓	-
VIII-7	TOTAL	19 ✓	
	<b>Accompanying items</b>	<b>paper document(s) attached</b>	<b>electronic file(s) attached</b>
VIII-8	Fee calculation sheet	✓	-
VIII-16	PCT-EASY diskette	-	diskette ✓
VIII-18	Figure of the drawings which should accompany the abstract	1	
VIII-19	Language of filing of the international application	Swedish	
IX-1	Signature of applicant or agent		
IX-1-1	Name (LAST, First)	HYNELL, /Magnus	

## FOR RECEIVING OFFICE USE ONLY

10-1	Date of actual receipt of the purported international application	24 -05- 2000
10-2	Drawings:	
10-2-1	Received X	
10-2-2	Not received	
10-3	Corrected date of actual receipt due to later but timely received papers or drawings completing the purported international application	
10-4	Date of timely receipt of the required corrections under PCT Article 11(2)	
10-5	International Searching Authority	ISA/SE
10-6	Transmittal of search copy delayed until search fee is paid	

## FOR INTERNATIONAL BUREAU USE ONLY

11-1	Date of receipt of the record copy by the International Bureau	27 JULY 2000	( 27. 07. 00 )
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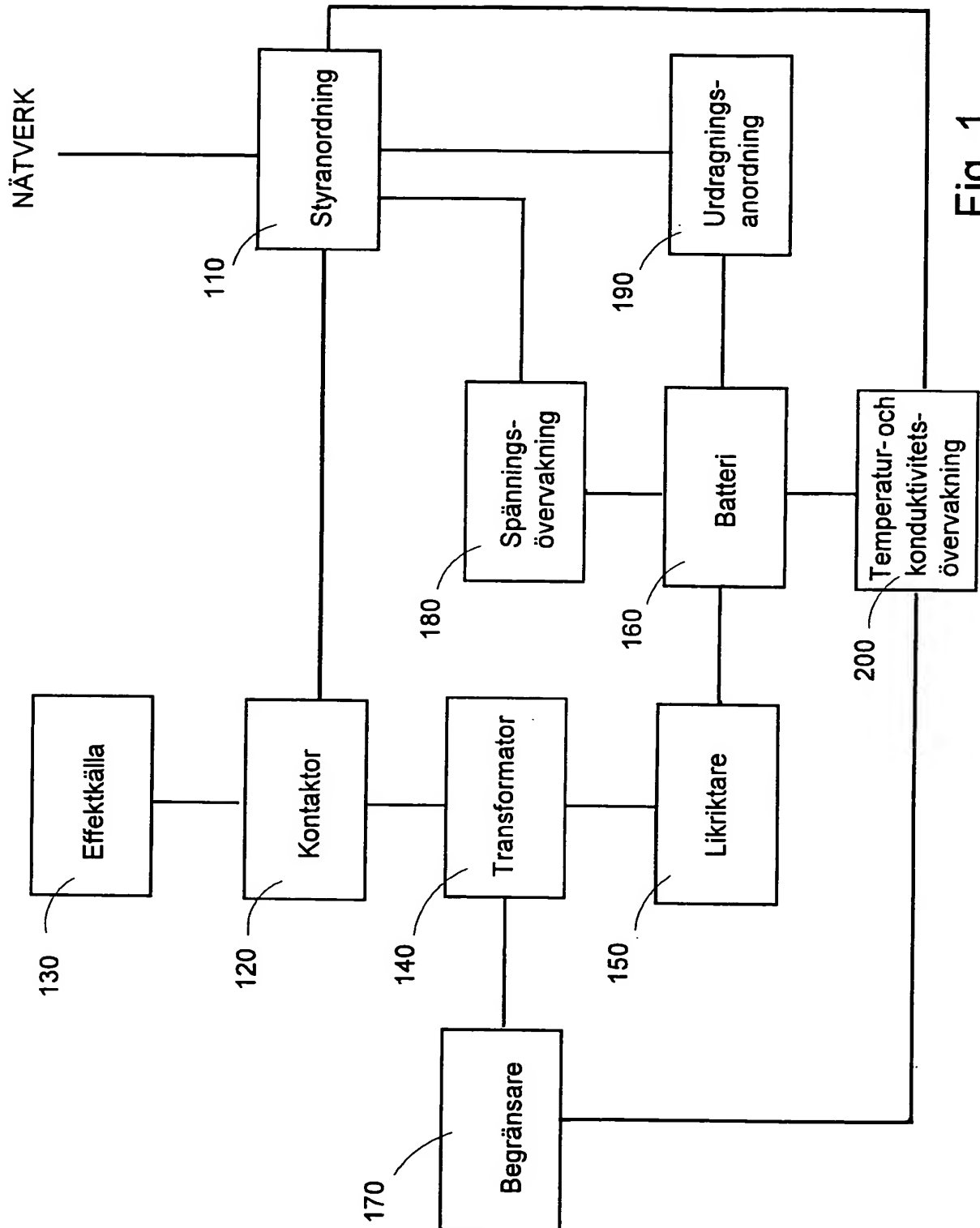


Fig. 1

## METOD OCH ANORDNING FÖR BATTERIER

### TEKNISKT OMRÅDE

5 Föreliggande uppfinning avser en metod och anordning för behandling, i form av regenerering, av ackumulatorer med minst en cell, företrädesvis blybatterier, varvid en varierande likspänning från ett laddaggregat pålägges i intermittenta strömledningsperioder, avbrutna av pauser utan ström, vilken likspänning är tillräcklig för att gasbildning skall uppstå i ackumulatorm.

### 10 TEKNIKENS STÅNDPUNKT

I en laddad blyackumulator, dvs ett blybatteri, består den verksamma substansen i de positiva elektroderna av blysuperoxid,  $\text{PbO}_2$ , och i de negativa elektroderna av poröst metalliskt bly. Vid urladdning av ackumulatorm förvandlas dessa verksamma substanser till blyulfat,  $\text{PbSO}_4$ , varvid sulfatjoner hämtas ur elektrolyten, som är svavelsyra. Vid 15 laddning är processen i princip den omvända. Dock är blyackumulatorer, konventionellt sett, begränsat återuppladdningsbara, då de återuppladdas medelst en kontinuerlig likström. Anledningen till detta är ej helt utredd, men det antas att faktorer som att urladdningsprodukterna är svårlösa i elektrolyten inverkar, varvid det anses att de tvåvärda blyjonernas diffusion utgör begränsning både vid urladdning och laddning. 20 Vidare är blyulfat en mycket dålig elektrisk ledare. Allt detta leder till att man ofta har problem med laddning av blybatterier, som bl.a. riskerar att bli förstörda av inaktiva skikt av blyulfat som hindrar laddning eller nedsätter kapaciteten och så småningom gör batteriet obrukbart. Därtill kommer problem med olika densitet före och efter laddning, vilket ger upphov till slam och nedsättning av hållfastheten.

25 I WO 94/28610 presenteras en lösning till ovanstående problem i samband med laddning av ackumulatorer, särskilt blybatterier. Enligt skriften kan således, utan märkbar temperaturförhöjning, blybatterier laddas med höga strömmar och med mycket gott resultat, då en likspänning pålägges batteriet i intermittenta strömledningsperioder, 30 avbrutna av pauser utan ström, vilka perioder uppgår till mellan ungefär 0,5 sekunder och ungefär 10 sekunder. Batteriet kan uppladdas från urladdat tillstånd, varvid intervallen för strömledning och pauser är ungefär lika långa, företrädesvis mellan 0,5 och 1,5 sekunder, varvid ett exempel anger en utnyttjad strömstyrka av 90 A, men det kan också underhållsladdas med strömledningsperioder av högst 0,5 sekunder, och 35 längre pauser däremellan, t.ex. 10 sekunder eller längre, vid lägre strömstyrkor. Processen syftar särskilt till att uppnå en snabb process för laddningen.

Ett problem med den teknik som beskrives i WO 94/28610, är att metoden inte anpassas för varje enskilt batteri som skall återuppladdas. Laddningsprocessen går heller ej att styra, annat än genom att man gör en grundinställning inför varje laddning som utföres, i vilken grundinställning man väljer om processen skall vara en laddning av ett urladdat  
5 batteri, eller en underhållsladdning av ett icke urladdat batteri. Metoden är ej heller anpassningsbar med hänsyn till erfarenheter från tidigare utförda laddningar, och är vidare ej inriktad på regenerering.

I US 1,743,594 beskrives en annan, äldre metod för laddning av batterier på kortast  
10 möjliga tid, vilken således ej syftar till att åstadkomma någon regenerering av batteriet. Laddningen äger därvid rum med pulser av upp till 100 A strömstyrka under perioder om 1,5 – 2 sekunder, med lika långa pauser dem emellan.

I US 3,963,976 beskrives ännu en metod för laddning av batterier, vilken ej är anpassad  
15 att åstadkomma regenerering av desamma. Syftet med metoden är att uppnå en genomblandning av elektrolyten genom den cirkulation som uppstår vid gasbildningen. I skriften anges strömstyrkor av upp till 1500 A kunna utnyttjas, men samtidigt varnas det för att längre pulstider kan vara skadliga. Det anges därvid att pulstiden kan vara 0,5 – 50 millisekunder, varvid strömstyrkans topp endast varar omkring en millisekund.  
20 Vidare anges det att pulserna skall genereras samtidigt som en konstant laddning äger rum, varvid det rekommenderas att pulsbehandlingen får äga rum i slutet av laddningen, dvs då batteriet är i det närmaste fulladdat.

Även i WO 96/17426 beskrivs ett system för laddning av blybatterier, varvid utnyttjas  
25 svaga strömpulser uppblandade med extremt korta strömledningspulser, "strömspikar", med relativt låga strömstyrkor. När cellspänningen nått en nivå då gasbildning påbörjas, övergår laddningen till konstantspänningsladdning tills batteriet är fullt laddat. Regleringen av anordningen utnyttjar en mikroprocessor och är baserad på mätningar av cellspänning och inre resistans.

30 Ett problem som inte löses av någon av de nyss nämnda metoderna är hur en regenerering av nedgångna batterier skall kunna genomföras på ett sätt som kan optimeras och styras för varje givet batteri. Istället syftar de nämnda metoderna till att åstadkomma en snabb och optimerad laddning eller underhållsladdning av mer  
35 konventionell typ.

## BESKRIVNING AV UPPFINNINGEN

- Ett syfte med föreliggande uppfinning är således att erbjuda en metod för behandling, i form av regenerering, av ackumulatorer, varvid behandlingsprocessen, i termer av strömledningsperiod, pauser och strömstyrka, styres utifrån givna indata. Som indata utnyttjas därvid under behandlingsprocessen, cellvis, registrerade processdata, företrädesvis åtminstone temperatur och konduktivitet, hos elektrolyten i ackumulatorm. Ytterligare indata för styrning av behandlingsprocessen utgöres av allmänna data för ackumulatorm/batteriet, vilka allmänna data inmatas vid behandlingsprocessens start. Styrningen av behandlingsprocessen utföres företrädesvis automatiserat, medelst för processen anpassad hård- och mjukvara, företrädesvis med utnyttjande av mikrodator eller dylikt. För styrningen kan också utnyttjas processdata från tidigare behandlingsprocesser, varvid sådana äldre processdata utgör erfarenhetsvärden som utnyttjas för att optimera den aktuella behandlingsprocessen.
- 15 Ett grundläggande syfte med metoden och anordningen enligt uppfinningen, är att åstadkomma en regenerering av batterier som är oförstörande för batteriet. Behandlingsprocessen skall vidare vara anpassningsbar och styrbar för varje enskilt batteri.
- 20 Således presenteras, enligt uppfinningen, en metod för behandling av ackumulatorer enligt patentkrav 1.
- Genom att strömupptagningsförmågan/konduktiviteten fastställs åtminstone för någon cell i batteriet under behandlingsprocessen, kan behandlingsprocessen styras med hjälp av en styrenhet, företrädesvis t.ex. mikrodator, utifrån uppmätta processdata, företrädesvis i form av åtminstone uppmätt temperatur och konduktivitet. Uppmätning av processdata och styrning utifrån dessa processdata, kan utföras individuellt för alla eller huvudsakligen alla celler i ackumulatorm. En alternativ, föredragen form av övervakning är att mäta den totala strömmen som flyter till ackumulatorm under strömledningsperioden. Detta sker genom övervakning av medelvärdet för temperatur och konduktivitet för ett antal strömledningsperioder, t.ex. tio stycken. När medelvärdet av de därpå följande strömledningsperioderna förblir i huvudsak konstant, t.ex. inom en gräns av typiskt omkring 5%, under en längre period, t.ex. omkring 1000 strömledningsperioder, så betyder detta att maximal/optimal regenerering uppstår med de inställda parametrarna.

- Vid behandlingsprocessen pålägges en likspänning, i regel en halv vågsl rikriktad växelspanning från ett vanligt laddaggregat, i intermittenta strömledningsperioder, avbrutna av pauser utan ström, vilka strömledningsperioder uppgår till mellan 0,01 och 10 sekunder, företrädesvis mellan 0,01 och 0,4 sekunder, och än mer föredraget mellan 0,1 och 0,25 sekunder. Mest föredraget utgöres en undre gräns för strömledningsperiodernas längd av 0,1 sekunder, företrädesvis 0,15 sekunder och en övre gräns av 0,5 sekunder, företrädesvis 0,4 sekunder och än mer föredraget 0,25 sekunder. Det har vid experimentella försök visat sig att en mycket fördelaktig strömledningsperiod är 0,18 sekunder. Vid behandlingen är det lämpligt att göra tidsintervallen för strömledning och paus olika långa, varvid pauserna är längre än strömledningsperioderna, med pauser om typiskt 1-20 sekunder, företrädesvis 1-10 sekunder och än mer föredraget 1-5 sekunder, typiskt omkring 3 sekunder, varvid de dock kan varieras individuellt genom att processen styres enligt föreliggande uppfinning. De kortaste pauserna inom intervallen utnyttjas i samband med de kortaste strömledningsperioderna inom intervallen, och tvärtom. Tack vare att pauserna är avsevärt längre än strömledningsperioderna uppnås också fördelen att ackumulatorm ej blir för varm under behandlingen. Vid strömledningsperioderna är den utnyttjade strömstyrkan 80-300 A eller ännu hellre upp till 1000 A, åtminstone för så kallade traktionära batterier, varvid de högsta värdena är relaterade till ackumulatorm då den är i relativt gott skick, och de lägsta värdena då den är i dåligt skick. Allra helst utnyttjas strömstyrkor av minst 110 A, företrädesvis minst 200 A och än mer föredraget minst 250 A för dylika traktionära batterier. För mindre batterier, t.ex. batterier för personbilar, utnyttjas däremot lägre strömstyrkor, normalt under 150 A, företrädesvis under 110 A, men inte lägre än 80 A.
- Då den uppfinningsenliga regenereringsprocessen påbörjas bör ackumulatorm ej vara helt urladdad men ej heller fulladdad, utan lämpligen vara delvis laddad, t.ex. omkring halvladdad. Vid underhållsladdning bör konstant, dvs kontinuerlig, laddning ske.
- Vid behandlingsprocessen enligt uppfinningen avlägsnas under urladdning uppbyggda föroreningar i form av sulfatkristaller på elektroderna. Genom de mycket korta strömperioderna, på bara någon tiondels sekund, med hög ström, som varvas med betydligt längre pauser, uppkommer en spräng- eller chockartad effekt, varvid de i batterisyran förekommande kristallerna sönderdelas, och rent bly utskiljs, vilket återförs till elektroderna (blyplattorna) vid återuppladdning av batteriet. För att en optimal effekt skall åstadkommas bör varje cell i ackumulatorm uppnå en spänning av minst 2,5 V under strömledningsperioderna, vilket säkerställs medelst ovan nämnda strömstyrkor

och pulstider. Energitillförseln under strömledningsperioderna är därvid högre än för kända metoder som enbart syftar till laddning och ej regenerering, men totalt sett är energitillförseln relativt låg, tack vare de relativt långa pauserna. Totalt sett motsvarar t.ex. pulsning vid 300 A en laddningsström av omkring 20 A.

- 5
- Enligt uppfinningen utföres behandlingsprocessen som en regenereringsprocess, varvid en viss, men normalt ej fullständig, laddning av ackumulatorm äger rum samtidigt som regenereringen, som en bieffekt av behandlingen. Efter regenereringen utföres lämpligen en urladdning av ackumulatorm, följt av en laddning. Även laddningen kan då
- 10 utföras med utnyttjande av en metod motsvarande metoden enligt uppfinningen, varvid dock processen styres på för laddningen optimalt sätt. Föredraget är dock att laddningen äger rum med konstant, d.v.s. kontinuerlig strömledning, efter regenereringen. Enligt en speciellt föredragen utföringsform utföres behandlingsprocessen i ett antal cykler, företrädesvis 5-30, och än mer föredraget 5-20 cykler för traktionära batterier.
- 15 Varje cykel består då av en regenereringsdel, typiskt med strömledningsperioder av kring 0,18 sekunder, och pauser av kring 3 sekunder, och en laddningsdel med standardladdning, d.v.s. med kontinuerlig strömtillförsel av typiskt 2,34 V. Varje regenereringsdel varar därvid i 2-8 timmar, företrädesvis 2-6 timmar och mest föredraget omkring 6 timmar, och konstantladdningsdelarna varar i 0,5-2 timmar,
- 20 företrädesvis omkring 1 timme. Utan att binda uppfinningen till en viss teori antas det därvid att konstantladdningen fungerar som en formatering av ytorna på elektroderna, på motsvarande sätt som äger rum vid uppladdning av ett helt nytt batteri. Härvid åstadkommes en maximal yta, med amorf struktur, på elektroderna. Det inses att behandlingsprocessen för regenereringen är relativt lång, och det är heller ej ett syfte i
- 25 sig att processen skall förkortas i förhållande till kända processer för laddning av batterier. Typiskt är behandlingstiden enligt uppfinningen minst 12 timmar lång, företrädesvis minst ett dygn lång, än mer föredraget minst två dygn lång och ända upp till flera dygn lång. Alternativt kan regenerering och laddning utföras samtidigt medelst metoden enligt uppfinningen, under lika långa totala behandlingstider.
- 30
- Enligt en aspekt av uppfinningen registreras processdata kontinuerligt under hela eller huvudsakligen hela behandlingsprocessen, varvid även styrningen av behandlingsprocessen utföres kontinuerligt. Pulslängd/strömledningsperiod, pauser och eventuellt strömstyrka är därvid företrädesvis anordnade att ändras/styras dynamiskt
- 35 under behandlingsprocessens gång. Vid den dynamiska ändringen/styrningen utnyttjas en styrenhet, företrädesvis en mikrokontroller, vilken utnyttjar en i minnet lagrad tabell med erfarenhetsvärden, för att anpassa strömlednings- och pauslängder i

regenereringsdelen av behandlingsprocessen. Även strömledningsperiodernas maximala amplitud kan begränsas, med hänsyn till allmänna data för ackumulatorm. Amplituden bör därvid ej överstiga ackumulatorns maximalt tillåtna laddningsström. Styrningen äger rum helt medelst mikrokontrollern, som styr t.ex. en triac mm, delvis via en D/A-  
5 omvandlare.

Enligt en annan aspekt av uppfinningen utföres registreringen av processdata under ett förutbestämt tidsintervall, av den totala behandlingstiden, företrädesvis under uppstart av behandlingen. Under uppstarten av behandlingen har man också möjlighet att  
10 detektera skadade celler i ackumulatorm, vilka skadade celler uppför sig på ett onormalt sätt, t.ex. genom att uppvisa mycket höga spänningar vid behandlingen.

Enligt ytterligare en aspekt av uppfinningen registreras processdata, åtminstone temperatur och konduktivitet, medelst därför anpassade sensorer. Detta kan utföras  
15 genom att ackumulatorm öppnas, så att sensorerna kan föras ned i elektrolyten i varje cell där processdata skall registreras. Alternativt kan mätningen/registreringen ske utifrån, genom utvändig registrering av temperatur samt konduktivitet, t.ex. genom induktiv mätning. Därvid kan ackumulatorm ha försetts med stationära sensorer i cellerna, vilka kommunicerar induktivt genom batterihöljet med t.ex. RFID teknik.

20 Temperatursensorema kan vara standard analoga temperaturgivare som kopplas till t.ex. en PT100 ingång i elektroniken. Även digitala givare är naturligtvis tänkbara. Konduktivitetsmätningen äger företrädesvis rum med två elektroder, företrädesvis av platina, och därtill anpassad elektronik som mäter ledningsförmågan i elektrolyten  
25 under pauserna i behandlingsprocessen. Andra, för ändamålet lämpade sensorer kan också utnyttjas.

Enligt ännu en aspekt av uppfinningen utgöres de allmänna data för batteriet, vilka utnyttjas som indata för styrning av behandlingsprocessen, av någon, några eller  
30 samtliga indata i gruppen som består av kundnamn, datum, batteritillverkare, typbeteckning för batteriet, typvärden för batteriet, tillverkningsår, tidpunkt för första idrifttagning av batteriet, tid mellan varje tidigare gjord behandling, typ av fordon i vilket batteriet utnyttjas och registrerade data från tidigare behandlingar, t.ex. cellspänning och elektrolytdensitet. Dessa allmänna data, eller åtminstone en  
35 huvudsaklig del av dem, kan vara inlagda i en datalagringsenhet som sitter på batteriet, t.ex. ett chips, en streckkod, eller i en databank i anordningen för behandlingen, eller dylikt.

Enligt ännu en aspekt av uppfinningen utföres behandling av ett visst batteri när den fastställda konduktiviteten vid en bestämd cellspänning för detta bestämda batteri uppnått ett förutbestämt kritiskt värde.

5

Enligt en annan aspekt av uppfinningen kan flera anordningar för behandling av ackumulatorer dela samma äldre processdata från tidigare behandlingsprocesser, genom att de kopplas samman i ett nätverk. Härigenom kan en enda server, i nätverket, innehålla en för anordningarna gemensam databas med erfarenhetsvärden från tidigare behandlingsprocesser. Vid behandling av ett visst batteri i en första behandlingsanordning, som är ansluten till nätverket, kan då, för styrningen, utnyttjas erfarenheter/processdata från tidigare behandlingar av likadana eller liknande batterier i andra behandlingsanordningar, som också är anslutna till nätverket.

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Behandlingsanordningarnas styrenheter kan anslutas till nätverket medelst GSM och/eller lokala radio/telemetriska kommunikationssystem, såsom dect, blue tooth, etc, eller motsvarande system. Genom nätverket och den gemensamma servern är det också möjligt att fjärrövervaka anordningarna och att uppgradera mjukvaran i deras styrenheter.

15

Eftersom varje ackumulator uppför sig på individuellt sätt, starkt beroende på dess historia, dvs den behandling och miljöpåverkan det utsatts för, så varierar den optimala behandlingsmetoden för olika ackumulatorer. Genom att sammanställa en databas, enligt ovan, vilken innehåller väsentliga parametrar för varje behandlad ackumulator, före, under och efter tidigare genomförda regenereringar i kombination med ackumulators typ, så kan en algoritmen (t.ex. i form av en formel eller matris) ställas upp för att uppnå bästa möjliga behandlingsprocess för varje ny behandling av en ackumulator. Ur en kommersiell aspekt kan det därvid vara extra viktigt att kunna förutsäga förväntad behandlingstid. En dylik databas byggs upp genom att man sammanför de data som samlats på största möjliga antal regenereringsmaskiner. Detta kan ske genom att dessa data manuellt föres samman och distribueras, vilket dock är svårt i praktiken varför den bästa lösningen är att koppla samman maskinerna i ett nätverk, permanent eller tillfälligt. Därvid kan ett klassiskt Server-Client nätverk (LAN) utnyttjas, eller Internet, för att uppnå ett globalt nätverk på ett enkelt sätt.

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## FIGURBESKRIVNING

I det följande kommer en anordning enligt uppfinningen för genomförande av metoden enligt uppfinningen att beskrivas, med hänvisning till Fig. 1, som utgöres av ett blockschema.

5

Den överordnade styrningen åstadkommes av en styrenhet 110, exempelvis en lämpligt programmerad mikroprocessor med kringkretsar, vilken styr ett omkopplingsorgan, såsom en kontaktor 120. Denna bryter och sluter en matningsväg för elektrisk energi, vilken tillhandahålles av en spänningskälla 130, t.ex. det allmänna elektriska nätet.

10 Spänningen transformeras till ett önskat värde medelst en transformator 140, varefter den tillföres en likriktare 150. Den likriktade spänningen tillföres därefter batteriet 160 som en behandlingsspänning.

En begränsningskrets 170 fungerar som överordnad styrning av ström och temperatur.

15 Om matningsströmmen eller batteritemperaturen, vilken övervakas av temperatur- och konduktivitetsövervakningen 200, blir alltför hög, deaktiveras likriktaren 150 och därigenom matningen till batteriet 160.

Styrenheten 110 styr kontaktorn 120 utifrån registrerade processdata, vilka processdata 20 registreras medelst temperatur-, och konduktivitetsövervakningen 200 samt en spänningsövervakningskrets 180. För styrningen utnyttjar styrenheten 110 också allmänna data för det aktuella batteriet, samt äldre processdata och allmänna data, vilka styrenheten har tillgång till via en nätverksuppkoppling. Vidare styr styrenheten 110 en urladdningskrets 190, medelst vilken batteriet kan laddas ur med en i förväg bestämd 25 ström.

Uppfinningen är ej begränsad av ovan beskrivna utföringsformer, utan kan varieras inom ramen för patentkraven. Anordningen och metoden är t.ex. även tillämpbar för andra typer av ackumulatorer än blybatterier, t.ex. nickel-kadmium- och nickel-järn- 30 ackumulatorer.

## PATENTKRAV

1. Metod för behandling, i form av regenerering, av ackumulatorer med minst en cell, företrädesvis blybatterier, varvid en varierande likspänning från ett laddaggregat  
5 pålägges i intermittenta strömledningsperioder, avbrutna av pauser utan ström, vilken likspänning är tillräcklig för att gasbildning skall uppstå i ackumulatorm, k ä n n e t e c k n a d a v att det under behandlingsprocessen registreras processdata för åtminstone en cell i ackumulatorm, vilka processdata utnyttjas för styrning av behandlingsprocessen.  
10
2. Metod enligt krav 1, k ä n n e t e c k n a d a v att sagda processdata utgöres av konduktivitet i en elektrolyt i cellen, och/eller temperatur i elektrolyten i cellen.
3. Metod enligt krav 1 eller 2, k ä n n e t e c k n a d a v att sensorerna för sagda  
15 processdata föres ned i elektrolyten i varje cell där processdata skall registreras.
4. Metod enligt något av ovanstående krav, k ä n n e t e c k n a d a v att det som styres under behandlingsprocessen är längd på sagda strömledningsperioder, vilka kan vara mellan 0,01 och 10 sekunder, företrädesvis minst 0,1 sekunder, än mer föredraget  
20 minst 0,15 sekunder och högst 0,5 sekunder, företrädesvis högst 0,4 sekunder och än mer föredraget högst 0,25 sekunder, längd på sagda pauser, vilka kan vara mellan 1-20 sekunder, företrädesvis 1-10 sekunder och än mer föredraget 1-5 sekunder, typiskt omkring 3 sekunder, varvid strömledningsperioderna företrädesvis är betydligt kortare än pauserna.  
25
5. Metod enligt något av ovanstående krav, k ä n n e t e c k n a d a v att en strömstyrka pålägges under strömledningsperioderna, vilken strömstyrka är tillräckligt stor för att varje cell i ackumulatorm skall bringas att uppnå en spänning av minst 2,5 V under strömledningsperioderna.  
30
6. Metod enligt något av ovanstående krav, k ä n n e t e c k n a d a v att en strömstyrka under sagda strömledningsperioder uppgår till mellan 80 och 1000 A, företrädesvis minst 110 A, företrädesvis minst 200 A och än mer föredraget minst 250 A, men högst 1000 A.  
35
7. Metod enligt något av kraven 1-5, k ä n n e t e c k n a d a v att en strömstyrka under sagda strömledningsperioder uppgår till mellan 80 och 1000 A, företrädesvis

högst 150 A och än mer föredraget högst 110 A.

8. Metod enligt något av ovanstående krav, k ä n n e t e c k n a d a v att  
behandlingsprocessen utföres i ett antal cykler, företrädesvis 5-30, och än mer  
5 föredraget 5-20 cykler, varvid varje cykel består av en regenereringsdel om 2-8  
timmar, företrädesvis 2-6 timmar och mest föredraget omkring 6 timmar och en  
laddningsdel, företrädesvis med standardladdning, d.v.s. med kontinuerlig  
strömtillförsel, under 0,5-2 timmar, företrädesvis omkring 1 timme.
- 10 9. Metod enligt något av ovanstående krav, k ä n n e t e c k n a d a v att sagda  
registrering av processdata och sagda styrning, utföres kontinuerligt under hela eller  
huvudsakligen hela behandlingsprocessen.
- 15 10. Metod enligt något av kraven 1-8, k ä n n e t e c k n a d a v att sagda registrering av  
processdata utföres under ett förutbestämt tidsintervall, av den totala  
behandlingstiden, företrädesvis under uppstart av behandlingen.
- 20 11. Metod enligt något av ovanstående krav, k ä n n e t e c k n a d a v att registrering  
av processdata och styrning utifrån dessa processdata, utföres individuellt för alla  
eller huvudsakligen alla celler i ackumulatorm.
- 25 12. Metod enligt något av ovanstående krav, k ä n n e t e c k n a d a v att den totala  
strömmen som flyter till ackumulatorm under strömledningsperioderna registreras,  
företrädesvis genom övervakning av ett medelvärde för sagda processdata för ett  
mindre antal strömledningsperioder, varvid optimal styrning, och därmed optimal  
behandling därefter säkerställs när medelvärdet av de därpå följande  
strömledningsperioderna under en längre period, förblir i huvudsak konstant.
- 30 13. Metod enligt något av ovanstående krav, k ä n n e t e c k n a d a v att allmänna data  
för varje enskild ackumulator, utnyttjas för styrningen av behandlingsprocessen,  
vilka allmänna data företrädesvis väljes ur gruppen som består av kundnamn, datum,  
ackumulatortillverkare, typbeteckning för ackumulatorm, typvärden för  
ackumulatorm, tillverkningsår, tidpunkt för första idrifttagning av ackumulatorm, tid  
mellan tidigare gjorda behandlingar, typ av anordning i vilket ackumulatorm  
35 utnyttjas, och vilka allmänna data företrädesvis registreras automatiskt vid uppstart  
av behandlingsprocessen.

14. Metod enligt krav 13, k ä n n e t e c k n a d a v att även äldre allmänna data och processdata, för andra ackumulatorer och/eller för tidigare behandlingar av den aktuella ackumulatorm, utnyttjas för styrningen av behandlingsprocessen.
- 5 15. Metod enligt krav 14, k ä n n e t e c k n a d a v att tillgång till sagda äldre allmänna data och äldre processdata säkerställs genom anslutning till ett nätverk med gemensam databas för dessa data för olika anordningar för behandlingen av ackumulatorer.
- 10 16. Metod enligt krav 15, k ä n n e t e c k n a d a v att sagda nätverk även är anordnat att utnyttjas för övervakning av behandlingsprocessen och/eller uppgradering av mjukvara för behandlingsprocessen.
- 15 17. Anordning för behandling, i form av regenerering, av ackumulatorer med minst en cell, företrädesvis blybatterier, vari ingår en transformator med en primärlindning avsedd att anslutas till elnätet, en sekundärlindning, en till sekundärlindningen ansluten likriktare, en positiv och en negativ anslutningsklämma, avsedda för anslutning till en ackumulator som skall behandlas, och en automatisk strömställar-anordning kopplad till primärlindningen för att intermittent till- och fränkoppla  
20 elnätet med korta strömledningsperioder avbrutna av pauser utan ström, k ä n n e t e c k n a d a v medel att registrera/mäta processdata, i åtminstone en cell i ackumulatorm, och medel att styra behandlingsprocessen utifrån dessa processdata.
- 25 18. Anordning enligt krav 17, k ä n n e t e c k n a d a v sagda medel att registrera/mäta processdata, utgöres av sensorer för registrering/mätning av konduktivitet i en elektrolyt i cellen, och/eller sensorer för registrering/mätning av temperatur i elektrolyten i cellen, varvid sagda registrering/mätning företrädesvis är anordnad att utföras genom öppnande av ackumulatorm och applicering av sagda sensorer.
- 30 19. Anordning enligt något av kraven 17-18, k ä n n e t e c k n a d a v att sagda medel att registrera/mäta processdata är anordnade att registrera/mäta processdata individuellt för alla eller huvudsakligen alla celler i ackumulatorm, varvid behandlingsprocessen företrädesvis är anordnad att styras individuellt för dessa celler utifrån processdata för varje cell.
- 35 20. Anordning enligt något av kraven 17-19, k ä n n e t e c k n a d a v att sagda medel att styra behandlingsprocessen innefattar en styrenhet, företrädesvis en mikrodator,

- samt medel att under behandlingsprocessen, dynamiskt ändra längden på sagda strömledningsperioder till mellan 0,01 och 10 sekunder, företrädesvis minst 0,1 sekunder, än mer föredraget minst 0,15 sekunder och högst 0,5 sekunder, företrädesvis högst 0,4 sekunder och än mer föredraget högst 0,25 sekunder, längden  
5 på sagda pauser, vilka kan vara mellan 1-20 sekunder, företrädesvis 1-10 sekunder och än mer föredraget 1-5 sekunder, typiskt omkring 3 sekunder, varvid strömledningsperioderna företrädesvis är betydligt kortare än pauserna, och, eventuellt, utnyttjad strömstyrka.
- 10 21. Anordning enligt något av kraven 17-20, k ä n n e t e c k n a d a v att anordningen är anordnad att avge en strömstyrka under sagda strömledningsperioder, vilken strömstyrka är tillräckligt stor för att varje cell i ackumulatorm skall bringas att uppnå en spänning av minst 2,5 V under strömledningsperioderna.
- 15 22. Anordning enligt något av kraven 17-21, k ä n n e t e c k n a d a v att anordningen är anordnad att avge en strömstyrka under sagda strömledningsperioder, vilken strömstyrka kan uppgå till mellan 80 och 1000 A, företrädesvis minst 110 A, företrädesvis minst 200 A och än mer föredraget minst 250 A, men högst 1000 A.
- 20 23. Anordning enligt något av kraven 17-21, k ä n n e t e c k n a d a v att anordningen är anordnad att avge en strömstyrka under sagda strömledningsperioder, vilken strömstyrka kan uppgå till mellan 80 och 1000 A, företrädesvis högst 150 A och än mer föredraget högst 110 A.
- 25 24. Anordning enligt något av kraven 17-23, k ä n n e t e c k n a d a v medel att, företrädesvis automatiskt, registrera/inmata allmänna data för varje enskild ackumulator, vilka allmänna data företrädesvis väljes ur gruppen som består av kundnamn, datum, ackumulatortillverkare, typbeteckning för ackumulatorm, typvärden för ackumulatorm, tillverkningsår, tidpunkt för första idrifttagning av  
30 ackumulatorm, tid mellan tidigare gjorda behandlingar, typ av anordning i vilket ackumulatorm utnyttjas.
25. Anordning enligt krav 24, k ä n n e t e c k n a d a v sagda anordning innefattar medel att ansluta den till en databas, företrädesvis via ett nätverk, för utnyttjande av  
35 äldre allmänna data samt processdata för tidigare behandlingsprocesser, för andra ackumulatorer och/eller för tidigare behandlingar av den aktuella ackumulatorm, i

styrningen av behandlingsprocessen.

26. Anordning enligt krav 25, k ä n n e t e c k n a d a v att sagda nätverk även är  
anordnat att utnyttjas för övervakning av behandlingsprocessen och/eller  
5 uppgradering av mjukvara för behandlingsprocessen.

### SAMMANFATTNING

- Metod för behandling, i form av regenerering, av ackumulatorer med minst en cell, företrädesvis blybatterier, varvid en varierande likspänning från ett laddaggregat pålägges i intermittenta strömledningsperioder, avbrutna av pauser utan ström, vilken
- 5 likspänning är tillräcklig för att gasbildning skall uppstå i ackumulatorm. Under behandlingsprocessen registreras processdata för åtminstone en cell i ackumulatorm, vilka processdata utnyttjas för styrning av behandlingsprocessen.

# HYNELL

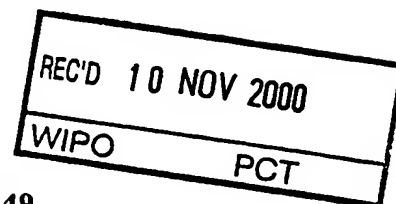
## PATENTTJÄNST AB

PATENT, TRADE MARKS AND DESIGN ATTORNEYS  
EUROPEAN PATENT & TRADE MARK ATTORNS

Peter Kylin, MSc., Patent Attorney, mobile +46-70-682 77 07  
Magnus Hynell, MSc., Patent Attorney, mobile +46-70-652 27 74  
Annika Björkman, MSc., Patent Attorney, mobile +46-70-348 54 58  
Kjell Lundahl, MSc., Patent Attorney, mobile +46 70-209 70 06  
Magnus Aspeby, MSc, Patent Attorney, in counsel  
Hans Carlström, MSc, Patent Engineer  
Britt Larnfelt, Trade Mark Agent  
Helena Wassén, LL.M., Business Law Attorney, mobile +46-70-216 63 23

Date: 8 November 2000  
Your ref:  
Our ref: P1446-100A

International Bureau of WIPO  
34, chemin des Colombettes  
CH-1211 GENEVE 20  
Schweiz



**International patent application no. PCT/SE00/01049**  
**Applicant: Holgia Aktiebolag**

In the above identified application, we herewith submit a new set of claims 1-26. New claim 1 has been amended to include features from previous claims 4 and 6 and/or 7. New claim 17 has been amended in the corresponding way, including features from previous claims 20 and 22 and/or 23.

The present invention aims at providing a method for treatment, in the form of regeneration, of worn accumulators, i.e. accumulators that do not react adequately on a conventional charging or maintenance charging. Furthermore, the invention aims at providing a regeneration process of this type, which in terms of current supply periods, pauses and current level, is controlled on basis of given input data. As input data there is used process data which is registered cell by cell during the treatment process, preferably at least a temperature and a conductivity in the electrolyte in the accumulator.

A basic object of the method and the device according to the invention is accordingly, as opposed to all of the cited references, to achieve a regeneration of batteries which is non destructive to the battery. Furthermore, the treatment process should be able to be adapted to, and controlled for, each individual battery.

In WO 94/28610 there is presented a method for charging batteries, especially lead batteries, i.e. not for regeneration of worn lead batteries. According to this reference, lead batteries may be charged with high current levels and with a very good result, without a significant increase in temperature, when a direct current is applied on the battery in intermittent current supply periods, interrupted by current free pauses, which periods have a length of between about 0.5 and 10 seconds. The battery may be charged from a discharged state, whereby the current supply periods and pauses are of approximately the same length, preferably between 0.5 and 1.5 seconds, Example 1 teaching a current level used of 90 A, but it may also be maintenance charged with current supply periods of 0.5 seconds at the most and pauses of greater length there between, e.g. 10 seconds or longer, at lower

**Postal address and Courier address:**  
Patron Carls väg 2  
SE-683 40 HAGFORS/UDDEHOLM  
Sweden

**Offices:**  
Hagfors  
Eslöv  
Lund  
Karlstad  
Borås  
Karlskoga

**Telephones:**  
+46 563-235 20  
+46 413-301 05  
+46 46-38 91 90  
+46 54-18 82 86  
+46 33-24 02 02  
+46 586-844 30

**Telefax:**  
+46 563-236 96  
  
**Bank account:**  
Nordbanken  
Account No 1179-100 168-8  
SWIFT-address: NBBKSESS

**E-mail:**  
headoffice@hynell.se  
  
**Postal account:**  
91 19 82-7

# HYNELL

## PATENTTJÄNST AB

PATENT, TRADE MARK & DESIGN RIGHTS  
EUROPEAN PATENTS, TRADE MARKS & DESIGNS

current levels. WO 94/28610 aims especially at achieving a fast process for charging batteries.

A problem with the technique which is described in WO 94/28610 is that the method is not adaptable to every individual battery which is to be recharged. Moreover, the charging process can not be controlled, other than by making a basic setting for each charging which is to take place, in which basic setting one chooses if the charging is to constitute a charging of a discharged battery or a maintenance charging of a non discharged battery. Also, the method is not adaptable in consideration to experiences from previously performed chargings, and is, as previously stated, not directed on regeneration.

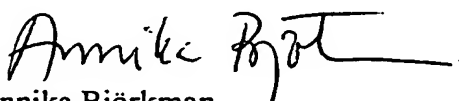
In WO 96/17426 too, there is described a system for the charging of batteries, i.e. not for regeneration of batteries, in which there is used weak current pulses which are mixed with extremely short current supply pulses, "current spikes", of relatively low current levels. When the cell voltage has reached a level where the generation of gas commences, the charging is altered into a constant voltage charging which continues until the battery is fully charged. The control of the device makes use of a microprocessor and is based on measurements of the cell voltage and the internal resistance.

As to US 4,650,729, this reference shows a battery which is supported by an additional energy source, i.e. a concept which differs entirely from the concept of the present invention.

Accordingly, a problem which is not solved by any of the cited methods is how to regenerate worn batteries in a manner which can be optimised and controlled for each given battery. Instead, the methods mentioned aim at performing a fast and optimised charging or maintenance charging of a more conventional type.

Respectfully submitted,

HYNELL PATENTTJÄNST AB

  
Annika Björkman

Encl.: New claims 1-26.

cc: Patent och registreringsverket  
Box 5055  
102 42 STOCKHOLM

Postal address and Courier address:  
Patron Carls väg 2  
SE-683 40 HAGFORS/UDDEHOLM  
Sweden

Offices:  
Hagfors  
Eslöv  
Lund  
Karlstad  
Borås  
Karlskoga

Telephones:  
+46 563-235 20  
+46 413-301 05  
+46 46-38 91 90  
+46 54-18 82 86  
+46 33-24 02 02  
+46 586-844 30

Telefax:  
+46 563-236 96  
  
Bank account:  
Nordbanken  
Account No 1179-100 168-8  
SWIFT-address: NBBKSESS

E-mail:  
headoffice@hynell.se  
  
Postal account:  
91 19 82-7

## PCT

Annika

## INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference P1446-100A	<b>FOR FURTHER ACTION</b> See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)	
International application No. PCT/SE00/01049	International filing date (day/month/year) 24.05.2000	Priority date (day/month/year) 15.06.1999
International Patent Classification (IPC) or national classification and IPC7 H 02 J 7/00, H 01 M 10/44		
Applicant HOLGIA AKTIEBOLAG ET AL.		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 3 sheets, including this cover sheet.

☒ This report is also accompanied by ANNEXES, i.e., sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

These annexes consist of a total of 8 sheets.

3. This report contains indications relating to the following items:

- I ☒ Basis of the report
- II ☐ Priority
- III ☒ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- IV ☐ Lack of unity of invention
- V ☐ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- VI ☐ Certain documents cited
- VII ☐ Certain defects in the international application
- VIII ☐ Certain observations on the international application

Date of submission of the demand  11.01.2001	Date of completion of this report  04.10.2001
Name and mailing address of the IPEA/SE Patent- och registreringsverket Box 5055 S-102 42 STOCKHOLM Facsimile No. 08-667 72 33	Authorized officer .  Håkan Sandh/AE Telephone No. 08-782 25 00

## 1. Basis of the report

1. With regard to the **elements** of the international application:\*

- ☐ the international application as originally filed
- ☒ the description:  
pages 1-8 , as originally filed  
pages \_\_\_\_\_ , filed with the demand  
pages \_\_\_\_\_ , filed with the letter of \_\_\_\_\_
- ☒ the claims:  
pages \_\_\_\_\_ , as originally filed  
pages 1-5 , as amended (together with any statement) under article 19  
pages \_\_\_\_\_ , filed with the demand  
pages \_\_\_\_\_ , filed with the letter of \_\_\_\_\_
- ☐ the drawings:  
pages \_\_\_\_\_ , as originally filed  
pages \_\_\_\_\_ , filed with the demand  
pages \_\_\_\_\_ , filed with the letter of \_\_\_\_\_
- ☐ the sequence listing part of the description:  
pages \_\_\_\_\_ , as originally filed  
pages \_\_\_\_\_ , filed with the demand  
pages \_\_\_\_\_ , filed with the letter of \_\_\_\_\_

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.These elements were available or furnished to this Authority in the following language English which is:

- ☐ the language of a translation furnished for the purposes of international search (under Rule 23.1(b)).
- ☒ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of the translation furnished for the purposes of international preliminary examination (under Rules 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. ☐ The amendments have resulted in the cancellation of:

- ☐ the description, pages \_\_\_\_\_
- ☐ the claims, Nos. \_\_\_\_\_
- ☐ the drawings, sheet/fig \_\_\_\_\_

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2 (c)).\*\*

\* Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are annexed to this report since they do not contain amendments (Rules 70.16 and 70.17).

\*\* Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.

## III. Non-establishment of opinion with regard to novelty, inventive step and industrial applicability

1. The questions whether the claimed invention appears to be novel, to involve an inventive step (to be non obvious), or to be industrially applicable have not been examined in respect of:

☐ the entire international application.

☒ claims Nos. 1-26

because:

☐ the said international application, or the said claims Nos. \_\_\_\_\_

relate to the following subject matter which does not require an international preliminary examination (*specify*):

☐ the description, claims or drawings (*indicate particular elements below*) or said claims Nos. \_\_\_\_\_  
are so unclear that no meaningful opinion could be formed (*specify*):

☐ the claims, or said claims Nos. \_\_\_\_\_ are so inadequately supported  
by the description that no meaningful opinion could be formed.

☒ no international search report has been established for said claims Nos. 1-26

2. A meaningful international preliminary examination cannot be carried out due to the failure of the nucleotide and/or amino acid sequence listing to comply with the standard provided for in Annex C of the Administrative Instructions:

☐ the written form has not been furnished or does not comply with the standard.

☐ the computer readable form has not been furnished or does not comply with the standard.

## PATENT COOPERATION TREATY

26 -03- 2001

From the INTERNATIONAL BUREAU

PCT

NOTIFICATION CONCERNING  
AMENDMENTS OF THE CLAIMS(PCT Rule 62 and  
Administrative Instructions, Section 417)

To:

Swedish Patent Office  
P.O. Box 5055  
S-102 42 Stockholm  
SUÈDE

Date of mailing (day/month/year)

19 March 2001 (19.03.01)

in its capacity as International Preliminary Examining Authority

International application No.

PCT/SE00/01049

International filing date (day/month/year)

24 May 2000 (24.05.00)

Applicant

HOLGIA AKTIEBOLAG et al

The International Bureau hereby transmits a copy of the amendments to the claims under Article 19 together with any accompanying statement (Rule 62).

The International Bureau of WIPO  
34, chemin des Colombettes  
1211 Geneva 20, Switzerland

Facsimile No. (41-22) 740.14.35

Authorized officer

Claudio Borton

Telephone No. (41-22) 338.83.38